Soil Properties and Yield of Direct Seeded Upland Autumn Rice (*Oryza sativa*) Varieties as influenced by Integrated Weed and Nutrient Management Practices

GAYATREE GOSWAMI*, DEBASHISH BARUAH, DEBAHASH BURAGOHAIN

Project Scientist*,
Assam Agricultural University,
Jorhat-785013
INDIA

Abstract: A field experiment was conducted during autumn season at Assam Agricultural University, ICR Farm, Jorhat, Assam to compare three different direct seeded upland rice varieties under different integrated weed and nutrient management practices. The experiment was carried out in factorial randomized block design replicated thrice with 15 treatments involving 3 varieties; Inglongkiri, Maizubiron and Rasi adopting 5 treatments of weed and nutrient management, i.e. 20-10-10 kg/ha N-P_2O_5-K_2O + pretilachlor @ 750 g/ha followed by grubber 30 DAS (W_1), 30-15-15 kg/ha N-P_2O_5-K_2O + pretilachlor @ 750 g/ha followed by grubber 30 DAS (W_2), 10-5-5 kg/ha N-P_2O_5-K_2O + pretilachlor @ 750 g/ha followed by grubber 30 DAS + Vermicompost @ 1 t/ha (at sowing & 30 DAS) + Sesbania (*Sesbania aculeata*) green mulch (up to 30 days) (W_3), 10-5-5 kg/ha N-P_2O_5-K_2O + pretilachlor @ 750 g/ha followed by grubber 30 DAS with intra-row spacing 15cm (W_4), and 20-10-10 kg/ha N-P_2O_5-K_2O + Weedy check (W_5). The physico-chemical properties of soil at harvest were not significantly influenced by variety as well as weed and nutrient management practices. Application of 10-5-5 kg/ha N-P_2O_5-K_2O, vermicompost @ 1t/ha, *Sesbania* green mulch, pretilachlor @ 750g a.i. /ha and grubber 30 DAS showed significantly higher soil microbial biomass carbon (323.72) at 30 DAS, significantly higher bacterial count at 75 DAS (23.07) and higher fungal count at 60 DAS (10.67), significantly higher NO_3-N at 35, 55 and 70 DAS, and NH_4-N at 15 DAS and 70 DAS. The results revealed an increase in yields as evident by higher grain and straw yield for all the three varieties was observed with pre-emergence application of pretilachlor (750 g a.i./ha) + grubber 30 days after sowing + 30-15-15 kg/ha N-P_2O_5-K_2O.

Key words: Direct seeded rice, variety, integrated weed and nutrient management, physico-chemical properties, NO_3^--N and NH_4^+-N content, microbial properties, yield

Received: August 11, 2022. Revised: May 13, 2023. Accepted: June 5, 2023. Published: July 3, 2023.

1. Introduction

Rice (*Oryza sativa* L.) is one of the most important food crops in the world, and staple food for more than 50% of the global population. Being the major source of food after wheat, it meets 43 % of calorie requirement of more than two third of the Indian population. In South Asia, rice was cultivated on 60 million hectares (m ha), and production was slightly above 225 million hectares (m t) of paddy, accounting for 37.5 and 32% of global area and production in 2013, respectively (Mohanty, 2014). In India, it is grown in an area of about 43.5 m ha with a total production of 105.5 m t and productivity of 2.4 t/ha during 2014-15

(Anon, 2016). Its cultivation is mainly practiced through transplanting which is cumbersome and labour intensive. Increasing water scarcity, water loving nature of rice and increasing labour wages trigger to switch for such alternative crop establishment methods which can increase water productivity. It has been recognized as the principal method of rice establishment since 1950's in developing countries (Pandey and Velasco, 2005). Improved short duration and high yielding varieties, nutrient and weed management techniques encouraged the farmers to shift from traditional system of transplanting to DSR culture. Direct seeding offers certain advantages like saving irrigation water, labour, energy, time, reduces emission of greenhouse-gases, better growth of succeeding crops, etc.

Direct seeded rice crop has a higher nutrient requirement as compared to a transplanted crop because of the higher plant density and greater production of biomass in the vegetative phase (Dingkuhn *et al*., 1990). Proper weed management practices along with integrated nutrient management (Sarkar and Gangwar, 2001), more particularly with major nutrients, significantly influence the crop productivity in upland situations. Fertilizer management can definitely alter the competitive balance between crops and weeds, but methods to incorporate it into integrated weed management are yet to be developed (Buhler, 2002).Integrated use of chemical fertilizers with manures, compost and green manure crops is very important for sustainable rice production especially under rainfed upland conditions (Meelu, 1996).

Application of manure compost may also enhance soil microbial activities that improve the crop growth, and restrain the pests and diseases Compared with chemical fertilizers, manure compost has been comprehensively tested and determined as effective in increasing nutrient availability to crops, thus improving grain yield in a cost-effective and environmentally friendly manner (Ahmad *et al*., 2007; Leite *et al*.,2010). The addition of manure compost can also increase the levels of organic matter and improve soil porosity, structural stability, moisture, and nutrient availability, as well as biological activity (Wang *et al*., 2011).

2. Materials and methods

A field experiment was conducted at ICR farm of Assam Agricultural University, Jorhat, Assam during the autumn season. The soil of experimental plot was sandy loam in texture with pH 4.95, organic carbon of 0.53% and 263.87, 22.10 and 134.71 kg/ha N, P and K, respectively. The experiment was carried out in factorial randomized block design replicated thrice with 15 treatments involving 3 varieties; Inglongkiri, Maizubiron and Rasi adopting 5 treatments of weed and nutrient management, *i.e.* 20-10-10 kg/ha N-P_2O_5-K_2O + pretilachlor @ 750 g/ha followed by grubber 30 DAS (W_1), 30-15-15 kg/ha N-P_2O_5-K_2O + pretilachlor @ 750 g/ha followed by grubber 30 DAS (W_2), 10-5-5 kg/ha N-P_2O_5-K_2O + pretilachlor @ 750 g/ha followed by grubber 30 DAS + Vermicompost @ 1 t/ha (at sowing & 30 DAS) + Sesbania (*Sesbania aculeata*) green mulch (up to 30 days) (W_3), 10-5-5 kg/ha N-P_2O_5-K_2O + pretilachlor @ 750 g/ha followed by grubber 30 DAS with intra-row spacing 15cm (W_4), and 20-10-10 kg/ha N-P_2O_5-K_2O + Weedy check (W_5).

The nutrients N, P_2O_5, K_2O were applied in the form of urea, single super phosphate (SSP) and muriate of potash (MOP), respectively. The required amounts of P_2O_5 fertilizers, as per treatment, were applied as basal in the lines one day prior to sowing and thoroughly mixed with the soil.

The required amounts of N and K_2O fertilizers, as per treatment, were applied in two splits. Half of nitrogenous and potassic fertilizers was applied 20 days after sowing. The second top dressing with the remaining quantities of nitrogenous and potassic fertilizers was done in 40 days after sowing. The vermicompost @ 1 t/ha was applied in rows in two equal splits *i.e.* at basal and 30 DAS. *Sesbania aculeata* as green mulch was grown and incorporated in soil at 30 days DAS. The pre-emergence application of pretilachlor (Craze 50 EC) was made by spraying the herbicide spray solution on the soil surface uniformly, one day after sowing of rice seed. The spray solution, on the basis of spray volume of 500 l/ha, was sprayed as per the treatments by using knapsack sprayer. While applying the pre-emergence herbicide, care was taken to ensure that the herbicide drift dose not reaches to adjacent experimental plots. Mechanical weeding, as per treatment, was done on 30 DAS by using manually operated grubber.

3. Results and discussion

3.1 Physico-chemical properties of soil: The soil physico-chemical properties like, pH, organic carbon, available N, P_2O_5 and K_2O did not differ significantly amongst the varieties as well as weed and nutrient management practices. This might be due to the fact that these physico-chemical properties of soil, generally, do not change significantly over short period of time. (Ian and Kulvadee, 2006).

3.2 Soil moisture content (%): The data on soil moisture content at 30, 60, 90 DAS and at harvest of crop are presented in Table 2. Soil moisture content varied from 19.09 % to 20.88 % throughout the crop growth period.

3.3 NO_3^--N and NH_4^+-N content in soil: Most plants absorb both NO_3^- and NH_4^+ mineral forms of N (Nascente *et al.*, 2012). NO_3-N predominates in the upland rice cultivation (D'Andrea *et al.*, 2004). No significant influence was observed on NO_3^--N and NH_4^+-N due to varieties. Application of 10-5-5 kg/ha N-P_2O_5-K_2O along with vermicompost @ 1t/ha, sesbania green mulch, pretilachlor @ 750g a.i./ha and grubber at 30 DAS showed significantly higher NO_3^--N at 15 and 35 DAS, and NH_4^+-N at 15 DAS, 55 DAS and 70 DAS. This might be due to application of fertilizers at sowing, 15 DAS and 40 DAS along with incorporation of vermicompost at sowing and 30 DAS. Moreover, this treatment also recorded significantly higher microbial population as well as soil microbial biomass carbon (Nascente *et al.*, 2012). Less amount of NH_4^+-N in upland condition might be due to its oxidation to NO_3 and higher NO_3^- -N is attributed to nitrification of NH_4^+-N under upland condition (Zia *et al.*, 2001).

3.4 Soil microbial biomass carbon: There was no significant difference in soil microbial biomass carbon at all three periods i.e. at initial, 30 DAS and at harvest of crop growth due to varieties. At 30 DAS, weed and nutrient management practice of application of 10-5-5 kg/ha N-P_2O_5-K_2O, vermicompost @ 1t/ha, sesbania green mulch, pretilachlor @ 750g a.i./ha and use of grubber 30 DAS showed significantly higher soil microbial biomass carbon (323.72) followed by that (308.53) in application of 30-15-15 kg/ha N-P_2O_5-K_2O along with pretilachlor @ 750 g a.i./ha and grubber 30 DAS. This might be due to application of organic source of nutrients including growing sesbania up to 30 DAS and then incorporated into soil which may improve the microbial activities. A similar finding was also reported by Shen *et al.*, 1984.

3.5 Bacterial and fungal populations: Varieties could not bring about significant difference in bacterial and fungal population at all the three stages *i.e.* initial, 30 DAS and at harvest of crop. Application of 10-5-5 kg/ha $N-P_2O_5-K_2O$ along with vermicompost @ 1t/ha, sesbania green

Table 1: Effect of variety, weed and nutrient management practices on available N, P_2O_5, K_2O, organic carbon and soil pH after harvest of rice

Treatment	Available N (kg ha^{-1})	Available P_2O_5 (kg ha^{-1})	Available K_2O (kg ha^{-1})	Organ Carbon (%)	Soil pH
Variety					
V_1: *Inglongkiri*	247.53	21.40	136.44	0.50	4.97
V_2: *Maizubiron*	250.67	20.75	136.69	0.51	4.95
V_3: Rasi	251.21	21.07	138.78	0.50	4.93
S.Em ±	6.68	0.23	4.25	0.12	0.05
CD (P = 0.05)	NS	NS	NS	NS	NS
Weed and nutrient management					
W_1: 20-10-10 kg/ha$N-P_2O_5-K_2O$ + pretilachlor @ 750 g a.i. ha^{-1}+ grubber 30 DAS	244.47	20.72	138.42	0.51	4.96
W_2: 30-15-15 kg/ha$N-P_2O_5-K_2O$ + pretilachlor @ 750 g a.i. ha^{-1}+ grubber 30 DAS	241.12	21.22	144.55	0.51	4.94
W_3: 10-5-5 kg/ha$N-P_2O_5-K_2O$ + vermicompost @ 1t/ha + sesbania green mulch + pretilachlor @ 750g a.i. ha^{-1}+ grubber 30 DAS	256.11	21.44	137.76	0.51	5.03
W_4: 10-5-5 kg/ha$N-P_2O_5-K_2O$ + intra-row spacing 15 cm + pretilachlor @ 750g a.i. ha^{-1}+ grubber 30 DAS	258.55	21.28	134.69	0.49	4.94
W_5: 20-10-10 kg/ha$N-P_2O_5-K_2O$ + weedy check	248.79	20.70	131.09	0.50	4.91
S.Em ±	8.63	0.30	5.49	0.10	0.06
CD (P = 0.05)	NS	NS	NS	NS	NS
Interaction (V×W)					
S.Em ±	14.94	0.52	9.51	0.13	0.11
CD (P = 0.05)	NS	NS	NS	NS	NS

Table 2: Effect of variety, weed and nutrient management practices on soil moisture content at different days after sowing (DAS) and at harvest of rice

(without statistical analysis)

Treatment	Soil moisture (%) at 0-15 cm depth			
	30 DAS	60 DAS	90 DAS	At harvest
Variety				
V_1: *Inglongkiri*	19.26	19.96	20.54	20.63
V_2: *Maizubiron*	19.57	20.39	20.75	19.96
V_3: Rasi	19.39	20.39	20.77	20.35
Weed and nutrient management				
W_1: 20-10-10 kg/haN-P_2O_5-K_2O + pretilachlor @ 750 g a.i. ha^{-1}+ grubber 30 DAS	19.17	20.03	20.27	20.80
W_2: 30-15-15 kg/haN-P_2O_5-K_2O + pretilachlor @ 750 g a.i. ha^{-1}+ grubber 30 DAS	19.09	20.29	21.00	20.29
W_3: 10-5-5 kg/haN-P_2O_5-K_2O + vermicompost @ 1t/ha + sesbania green mulch + pretilachlor @ 750 g a.i. ha^{-1}+ grubber 30 DAS	19.59	20.37	20.64	20.60
W_4: 10-5-5 kg/haN-P_2O_5-K_2O + intra-row spacing 15 cm + pretilachlor @ 750 g a.i. ha^{-1}+ grubber 30 DAS	19.47	20.32	20.88	19.79
W_5: 20-10-10 kg/haN-P_2O_5-K_2O + weedy check	19.72	20.20	20.66	20.08

Field capacity=23.5%

PWP=11.4%

Table 3: Effect of variety, weed and nutrient management practices on soil microbial biomass carbon at initial, 30 days after sowing (DAS) and at harvest of rice

Treatment	Soil Microbial Biomass Carbon ($\mu g\ g^{-1}$ soil)		
	Initial	30 DAS	Harvest
Variety			
V_1: *Inglongkiri*	153.92	274.30	133.24
V_2: *Maizubiron*	153.10	275.89	129.80
V_3: Rasi	155.93	281.02	139.34
S.Em ±	9.05	14.36	7.27
CD (P = 0.05)	NS	NS	NS
Weed and nutrient management			
W_1: 20-10-10 kg/haN-P_2O_5-K_2O + pretilachlor @ 750g a.i. ha^{-1}+ grubber 30 DAS	166.66	275.32	139.50
W_2: 30-15-15 kg/haN-P_2O_5-K_2O + pretilachlor @ 750g a.i. ha^{-1}+ grubber 30 DAS	169.89	308.53	138.28
W_3: 10-5-5 kg/haN-P_2O_5-K_2O + vermicompost@ 1t/ha + sesbania green mulch + pretilachlor @ 750g a.i. ha^{-1}+ grubber 30 DAS	144.12	323.72	134.67
W_4: 10-5-5 kg/haN-P_2O_5-K_2O + intra-row spacing 15 cm + pretilachlor @ 750g a.i. ha^{-1}+ grubber 30 DAS	137.98	250.72	129.24
W_5: 20-10-10 kg/haN-P_2O_5-K_2O + weedy check	152.93	227.06	128.97
S.Em ±	11.69	18.54	9.39
CD (P = 0.05)	NS	53.70	NS

Table 4: Effect of variety, weed and nutrient management practices on NH_4^+ -N at different days after sowing (DAS) of rice

Treatment	NH_4^+ -N (kg/ha soil)			
	15 DAS	35 DAS	55 DAS	70 DAS
Variety				
V_1: *Inglongkiri*	28.67	44.48	43.20	35.14
V_2: *Maizubiron*	25.61	44.61	42.94	32.51
V_3: Rasi	26.84	46.88	45.34	33.67
S.Em ±	0.97	1.12	2.05	0.91
CD (P = 0.05)	NS	NS	NS	NS
Weed and nutrient management				
W_1: 20-10-10 kg/haN-P_2O_5-K_2O + pretilachlor @750g a.i. ha^{-1}+ grubber 30 DAS	27.35	46.24	43.57	33.91
W_2: 30-15-15 kg/haN-P_2O_5-K_2O + pretilachlor @ 750 g a.i. ha^{-1}+ grubber 30 DAS	29.32	47.11	45.40	36.17
W_3: 10-5-5 kg/haN-P_2O_5-K_2O + vermicompost @ 1t/ha + sesbania green mulch + pretilachlor @ 750 g a.i. ha^{-1}+ grubber 30 DAS	31.72	47.12	42.14	37.99
W_4: 10-5-5 kg/haN-P_2O_5-K_2O + intra-row spacing 15 cm + pretilachlor @ 750 g a.i. ha^{-1}+ grubber 30 DAS	26.64	44.30	45.52	33.64
W_5: 20-10-10 kg/haN-P_2O_5-K_2O+ weedy check	20.16	41.83	42.49	27.16
S.Em ±	1.25	1.45	2.65	1.18
CD (P = 0.05)	3.63	NS	2.80	7.21

Table 5: Effect of variety, weed and nutrient management practices on NO_3^+- N at different growth stages of rice

Treatment	NO_3^+- N (kg/ha soil)			
	15 DAS	35 DAS	55 DAS	70 DAS
Variety				
V_1: *Inglongkiri*	38.67	53.28	49.21	38.48
V_2: *Maizubiron*	35.61	53.21	50.09	38.61
V_3: Rasi	36.84	54.81	51.46	40.88
S.Em ±	0.97	1.17	1.14	1.12
CD (P = 0.05)	NS	NS	NS	NS
Weed and nutrient management				
W_1: 20-10-10 kg/haN-P_2O_5-K_2O + pretilachlor @ 750 g a.i. ha^{-1}+ grubber 30 DAS	37.35	56.24	50.24	40.24
W_2: 30-15-15 kg/haN-P_2O_5-K_2O + pretilachlor @ 750 g a.i. ha^{-1}+ grubber 30 DAS	39.32	57.11	51.11	41.11
W_3: 10-5-5 kg/haN-P_2O_5-K_2O + vermicompost @ 1t/ha + sesbania green mulch + pretilachlor @ 750 g a.i. ha^{-1}+ grubber 30 DAS	41.72	57.12	51.12	41.12
W_4: 10-5-5 kg/haN-P_2O_5-K_2O + intra-row spacing 15 cm + pretilachlor @ 750 g a.i. ha^{-1}+ grubber 30 DAS	36.64	50.64	50.62	38.30
W_5: 20-10-10 kg/haN-P_2O_5-K_2O + weedy check	30.16	47.72	48.17	35.83
S.Em ±	1.25	1.52	1.47	1.45
CD (P = 0.05)	3.62	4.39	NS	NS

Table 6: Effect of variety, weed and nutrient management practices on bacterial count at different days after sowing (DAS) of rice

Treatment	Bacterial count (-log x 10^{-6} cfu/g soil)		
	40 DAS	60 DAS	75 DAS
Variety			
V_1: *Inglongkiri*	16.26	18.89	21.23
V_2: *Maizubiron*	15.83	18.73	20.80
V_3: Rasi	16.83	19.53	21.27
S.Em ±	0.52	0.68	0.67
CD (P = 0.05)	NS	NS	NS
W_1: 20-10-10 kg/haN-P_2O_5-K_2O + pretilachlor @ 750g a.i. ha^{-1}+ grubber 30 DAS	16.68	19.89	22.07
W_2: 30-15-15 kg/haN-P_2O_5-K_2O + pretilachlor @ 750g a.i. ha^{-1}+ grubber 30 DAS	17.34	20.11	23.07
W_3: 10-5-5 kg/haN-P_2O_5-K_2O + vermicompost @ 1t/ha + sesbania green mulch + pretilachlor @750 g a.i. ha^{-1}+ grubber 30 DAS	16.31	19.41	21.69
W_4: 10-5-5 kg/haN-P_2O_5-K_2O + intra-row spacing 15 cm + pretilachlor @ 750 g a.i. ha^{-1}+ grubber 30 DAS	15.75	18.29	20.25
W_5: 20-10-10 kg/haN-P_2O_5-K_2O + weedy check	15.46	17.56	18.40
S.Em ±	0.68	0.81	0.87
CD (P = 0.05)	NS	NS	2.52

Table 7: Effect of variety, weed and nutrient management practices on fungal count at different days after sowing (DAS) of rice

Treatment	Fungal count (-log x 10^{-6} cfu/g soil)		
	40 DAS	60 DAS	75 DAS
Variety			
V_1: *Inglongkiri*	9.40	11.20	12.48
V_2: *Maizubiron*	8.87	11.20	12.31
V_3: Rasi	10.53	12.13	14.10
S.Em ±	0.51	0.42	0.72
CD (P = 0.05)	NS	NS	NS
W_1: 20-10-10 kg/haN-P_2O_5-K_2O + pretilachlor @ 750g a.i. ha^{-1}+ grubber 30 DAS	10.17	11.72	13.64
W_2: 30-15-15 kg/haN-P_2O_5-K_2O + pretilachlor @ 750g a.i. ha^{-1}+ grubber 30 DAS	10.67	12.56	14.57
W_3: 10-5-5 kg/haN-P_2O_5-K_2O + vermicompost @ 1t/ha + sesbania green mulch + pretilachlor @750 g a.i. ha^{-1}+ grubber 30 DAS	10.06	11.83	13.11
W_4: 10-5-5 kg/haN-P_2O_5-K_2O + intra-row spacing 15 cm + pretilachlor @ 750 g a.i. ha^{-1}+ grubber 30 DAS	9.22	11.22	12.11
W_5: 20-10-10 kg/haN-P_2O_5-K_2O + weedy check	7.89	10.22	11.39
S.Em ±	0.65	0.54	0.94
CD (P = 0.05)	1.90	NS	NS

Table 8: Effect of variety, weed and nutrient management practices on grain yield, straw yield and harvest index of rice

Treatment	Grain yield (kg/ha)	Straw yield (kg/ha)
Variety		
V_1: *Inglongkiri*	1596	2105
V_2: *Maizubiron*	1550	2103
V_3: Rasi	1605	2017
S.Em ±	20	11
CD (P = 0.05)	NS	31
Weed and nutrient management		
W_1: 20-10-10 kg/haN-P_2O_5-K_2O + pretilachlor @ 750g a.i. ha^{-1}+ grubber 30 DAS	1877	2533
W_2: 30-15-15 kg/haN-P_2O_5-K_2O + pretilachlor @ 750g a.i. ha^{-1}+ grubber 30 DAS	2087	2631
W_3: 10-5-5 kg/haN-P_2O_5-K_2O + vermicompost @ 1t/ha + sesbania green mulch + pretilachlor @ 750g a.i. ha^{-1}+ grubber 30 DAS	1679	2256
W_4: 10-5-5 kg/haN-P_2O_5-K_2O + intra-row spacing 15 cm + pretilachlor @ 750g a.i. ha^{-1}+ grubber 30 DAS	1573	2092
W_5: 20-10-10 kg/haN-P_2O_5-K_2O + weedy check	703	863
S.Em ±	26	14
CD (P = 0.05)	75	40
Interaction (V×W)		
S.Em ±	45	24
CD (P = 0.05)	131	70

Table 8.1 Interaction effect of variety with weed and nutrient management practices on grain yield (kg/ha) of rice

Variety	Weed and nutrient management				
	W_1	W_2	W_3	W_4	W_5
V_1	1900	2068	1676	1573	765
V_2	1782	2005	1619	1553	789
V_3	1950	2187	1742	1593	555
SEm±	45				
C.D. (P=0.05)	131				

Table 8.2 Interaction effect of variety with weed and nutrient management practices on straw yield (kg/ha) of rice

Variety	Weed and nutrient management				
	W_1	W_2	W_3	W_4	W_5
V_1	2550	2624	2275	2126	951
V_2	2542	2658	2265	2121	929
V_3	2507	2612	2228	2029	710
SEm±	24				
C.D. (P=0.05)	70				

mulch, pretilachlor @ 750 g a.i./ha and working with grubber 30 DAS showed significantly higher bacterial population at 75 DAS and fungal population at 40 DAS. This might be due to application of organic manure *i.e.* (i) vermicompost at initial and 30 DAS (ii) growing of sesbania as green mulch which was incorporated into soil at 30 DAS. Similar findings were reported by Zia *et al.* (2001) and D'Andrea *et al.* (2004).

3.6 Grain yield and straw yield (kg/ha): A perusal of the findings revealed that there was no significant difference in grain yield amongst the three varieties tested while Inglonkiri showed significantly higher straw yield. It might be due to significantly higher plant height at harvest in Inglongkiri. Regarding the factor, weed and nutrient management, application of 30-15-15 kg/ha N-P_2O_5-K_2O along with pretilachlor @ 750 g a.i./ha and use of grubber 30 DAS (W_2) showed significantly higher grain yield and straw yield. The higher grain yield might be due to better nutrition of rice crop owing to application of higher dose of major nutrients as well as reduction in crop weed competition due to combined methods of weed control *i.e.* chemical and mechanical, that resulted in statistically superior growth characters (LAI, number of tillers and dry matter accumulation) and yield attributing characters (number of panicles, panicle length and number of filled grains). Kavitha *et al.,* (2010) reported that application of pretilachlor suppressed the weed in the early growth stages of *autumn* rice leading to higher yield. The higher straw yield might be due to higher amount of dry matter production at 30 and 60 DAS in W_2. The improved cultivars produced higher yields than traditional cultivars in both high and low fertility conditions (Saito *et al*., 2006). The grain and straw yield were affected significantly by the interaction effect of varieties and weed and nutrient management practices. The results revealed that higher grain yield was given by Rasi, when combined with application of 30-15-15 kg/ha N-P_2O_5-K_2O along with pretilachlor @ 750 g a.i./ha and use of grubber 30 DAS (W_2) while Inglongkiri showed significantly higher straw yield when combined with W_2.

4. Conclusion

The pH, organic carbon, available N, P_2O_5 and K_2O in soil at harvest were not significantly influenced by variety or weed and nutrient management practices. Varieties showed no significant effect on soil microbial biomass carbon, bacterial and fungal count, and NO_3-N and NH_4-N content in soil. However, application of 10-5-5 kg/haN-P_2O_5-K_2O, vermicompost @ 1t/ha, *Sesbania* green mulch, pretilachlor @ 750g a.i./ha and grubber 30 DAS showed significantly higher soil microbial biomass carbon (323.72) at 30 DAS and also gave significantly higher bacterial count at 75 DAS (23.07) and higher fungal count at 60 DAS (10.67). This was followed by that in 30-15-15 kg/haN-P_2O_5-K_2O along with pretilachlor @ 750 g a.i./ha and grubber 30 DAS. Application of 10-5-5 kg/ha N-P_2O_5-K_2O along with vermicompost @ 1 t/ha, *Sesbania* green mulch, pretilachlor @ 750 g a.i. /ha and grubber 30 DAS gave significantly higher NO_3-N at 35, 55 and 70 DAS, and NH_4-N at 15 DAS and 70 DAS. Variety *Inglongkiri* resulted significantly higher straw yield (21.05) but was at par with that in *Maizubiron* (21.03) but both were significantly superior to that in Rasi (20.17). The grain yield (2087) and straw yield (2631) recorded with application of 30-15-15 kg/ha N-P_2O_5-K_2O along with pretilachlor @ 750 g a.i. /ha and grubber 30 DAS was significantly higher than that (1877 and 2533) in application of 20-10-10 kg/haN-P_2O_5-K_2O along with pretilachlor @ 750 g/ha and working with grubber 30 DAS.

Acknowledgements

We are grateful to DPGS and Department of Agronomy, College of Agriculture, Assam Agricultural University, Jorhat for providing the necessary infrastructural facilities.

References

[1]. Ahmad, R.; Jilani, G.; Arshad, M.; Zahir, Z.A. and Khalid, A. 2007. Bio-conversion of organic wastes for their recycling in agriculture: an overview of perspectives and prospects. Ann Microbiol 57: 471–479.

[2]. Anonymous. 2016. Area and production of rice in India. (http// *www.indiastat.com*).

[3]. Buhler, D. D. 2002. Challenges and opportunities for integrated weed management. *Weed Sci*. **50**: 273-280.

[4]. D'Andréa, A. F.; Silva, M. L. N.; Curi, N. and Guilherme, L.R.G. 2004. Carbon and nitrogen storage, and inorganic nitrogen forms in a soil under different management systems. **39**: 179-186.

[5]. Dingkuhn, M.; Schnier, H.F. and Dorffling, K. 1990. Diurnal and development changes in canopy gas exchange in relation to growth in transplanted and direct seeded flooded rice. *Aus. J. Pl. Phy*. **17**: 119-34.

[6]. Ian, G. and Kulvadee K. 2006. Impact of fallow length on soil structure and

soil water characteristics in a swidden cultivation system of western Thailand. *Soil Biol. Biochem.* **3**(4): 458-460.
[7]. Kavitha, M. P.; Ganesaraja, V.; Paulpandi, V. K. and Subramanian, R. B. 2010. Effect of age of seedlings, weed management practices and humic acid application on system of rice intensification. *Indian J. Agril. Res.* **44**(4): 294-299.
[8]. Leite, L.F.C.; Oliveira, F.C.; Araujo, A.S.F.; Galvao, S.R.S. and Lemos, J.O. 2010. Soil organic carbon and biological indicators in an Acrisol under tillage systems and organic management in north-eastern Brazil. Soil Res 48: 258–265.
[9]. Meelu, O. P. 1996. Integrated nutrient management for ecologically sustainable agriculture. In 23rd Tamhane Memorial Lecture, National seminar on developments in soil science. Gujarat Agric. University, Anand
[10]. Mohanty, S. 2014.Rice in South Asia. *Rice Today*.**13** (2): 40 – 41.
[11]. Nascente, A. S.; Crusciol, C. A. C. & Cobucci, T. (2012). Ammonium and nitrate in soil and upland rice yield as affected by cover crops and their desiccation time. *J. of Crop Sci*. **47**(12):1700-1706
[12]. Pandey, S. and Velasco, L. 2002. Economics of direct seeding in Asia: Patterns of adoption and research priorities. In: Direct Seeding: Research Strategies and Opportunities, (Eds.). International Rice Research Institute, Manila, Philippines, pp. 3-14.
[13]. Saito, K.; Linquist, B.; Atlin, G. N.; Phanthaboon, K.; Shiraiwa , T. and Horie, T. 2006. Response of traditional and improved upland rice cultivars to N and P fertilizer in northern Laos. *Field Crops Research* **96**: 216-223.
[14]. Sarkar, A. and Gangwar, B. 2001. Integrated nutrient management in rice based cropping systems under different agro-ecosystems. *Oryza*. **38**: 35-37.
[15]. Shen, S. M.; Pruden, G. and Jenkinson, D. S. 1984. Mineralization and im-mobilization of nitrogen in fumigated soil and the measure-ment of microbial biomass nitrogen. *Soil Biol Biochem*. **16**:437–444.
[16]. Wang, W.; Niu, J.; Zhou, X. and Wang, Y.2011. Long-term change in land management from subtropical wetland to paddy field shifts soil microbial community structure as determined by PLFA and T-RFLP. *Pol J Eco.* **59**: 37–44.
[17]. Zia, M. S.; Mahmood, I. A.; Aslam, M.; Yasin, M. and Khan, M. A. 2001. Nitrogen dynamics under aerobic and anaerobic soil conditions. *Int. J. of Agric. and Biology*. **3**(4): 458-460.